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(54) VOLUMETRIC ULTRASOUND IMAGE DATA REFORMATTED AS AN IMAGE PLANE SEQUENCE

ALS BILDEBENENSEQUENZEN FORMATIERTE VOLUMETRISCHE ULTRASCHALLBILDDATEN

DONNÉES D'IMAGE ÉCHOGRAPHIQUE VOLUMÉTRIQUES REFORMATÉES SOUS LA FORME D'UNE SÉQUENCE DE PLANS D'IMAGE

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- **POULSEN C ET AL: "An optical registration method for 3D ultrasound freehand scanning", ULTRASONICS SYMPOSIUM, 2005 IEEE ROTTERDAM, THE NETHERLANDS 18-21 SEPT. 2005, PISCATAWAY, NJ, USA,IEEE, vol. 2, 18 September 2005 (2005-09-18), pages 1236-1240, XP010899187, DOI: DOI:10.1109/ULTSYM.2005.1603075 ISBN: 978-0-7803-9382-0**

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Description

[0001] This invention relates to medical diagnostic ultrasound systems and, in particular, to ultrasound systems for three dimensional (3D) imaging which are capable of exporting volumetric image data as a sequence of planar images.

[0002] Ultrasonic diagnostic imaging has traditionally scanned two-dimensional cross-sectional images of anatomy of the body. As the technology has developed, ultrasound can now scan and image three dimensional volumes, in both still images and real time. The 3D datasets of a scanned volume can be successively rendered as three dimensional views, rapidly enough for the clinician to observe the motion of the anatomy in real time movement. But radiologists and cardiologists are still more familiar with seeing the standard 2D planar images of anatomy and many are still not comfortable with diagnosing anatomy in 3D, a challenge made more difficult by the tissue clutter which often surrounds and obscures the region of interest at the center of the volume being imaged. As a result, many physicians prefer to see planar 2D image "slices" of a 3D volume. Once a 3D volume image dataset has been captured, a technique called multiplanar reformatting enables the clinician to select one or more cut planes through the volume for viewing as 2D images. In the typical user interface the clinician can position three orthogonal lines in the volume image. Each line represents the position of one of three orthogonal image planes through the volume, an x-y plane (azimuth vs. depth), a y-z plane (depth vs. elevation, and an x-z plane (azimuth vs. elevation). As the lines are repositioned, 2D images of the corresponding cut planes are formed by the voxels of the dataset intercepted by the cut planes. See U.S. Pat. 6,572,547 (Miller et al.), which illustrates the use of such cut planes to visualize the tip of a catheter from the three different imaging perspectives.

[0003] Poulsen C. et al.: "An optical registration method for 3D ultrasound freehand scanning", Ultrasonics Symposium, 2005 IEEE Rotterdam, The Netherlands 18-21 Sept. 2005, Piscataway, NJ, USA, IEEE, Vol. 2, 18 September 2005, pages 1236-1240 presents an optical registration system, which tracks the position of the transducer on the skin surface. This is done continuously by acquiring images of the skin at the transducer location with a CCD-array, attached on the side of the transducer.

[0004] WO 03/045222 A2 furthermore discloses a system and method for visualization and navigation of three-dimensional medical images. A user interface displays medical images and enables user interaction with the medical images. The user interface comprises an image area that is divided into a plurality of views for viewing corresponding two-dimensional and three-dimensional images of an anatomical region.

[0005] A further limitation of three dimensional imaging is that the datasets of 3D images are formatted differently by various ultrasound imaging system vendors, as the vendors try to process and accommodate the storage of the large (3D) datasets inherent in three dimensional imaging. In an effort to align these different proprietary approaches, a working group of the DICOM Standards Committee published Supplement 43 to the standard in April, 2009 directed specifically to a DICOM standard for storing 3D ultrasound images ("Digital Imaging and Communications in Medicine (DICOM), Supplement 43: Storage of 3D Ultrasound Images, Annex X, 10 April 2009). However implementation of this standard for 3D ultrasound images has not been rapid, and the plans of different vendors for converting imaging systems such as PACS systems to the new 3D standard remain largely unknown. Accordingly there remains a need to provide 3D image data in a standardized format which readily lends itself to transport and use on other medical image platforms which have not implemented the DICOM standard for 3D ultrasound images.

[0006] In accordance with the principles of the present invention, an ultrasound system according to independent claim 1 is provided. This ultrasound system reformats 3D image data as one or more sequences of 2D images in respective cut plane directions which can be ported to other imaging platforms and replayed and diagnosed as a standardized 2D real time image sequence. A user interface provides selection of the cut plane direction, the spacing of the planes, and/or the number of images in the sequence. The volume is then reformatted into planar images in the selected cut plane direction(s) and stored as one or more image sequences, enabling replay of each sequence on most conventional medical imaging platforms, preferably as 2D DICOM image sequences.

[0007] In the drawings:

FIGURE 1 illustrates in block diagram form an ultrasound system constructed in accordance with the principles of the present invention.

FIGURE 2 illustrates a sequence for acquiring a 3D dataset and reformatting the data as one or more planar image sequences.

FIGURE 3 illustrates lines over a 3D image indicating position of cut planes.

FIGURE 4 illustrates the formation of three planar image sequences from a volumetric image dataset in accordance with the present invention.

[0008] Referring to FIGURE 1, an ultrasound system constructed in accordance with the principles of the present invention is shown in block diagram form. An ultrasound probe 10 with an array transducer 12 transmits ultrasound waves into the body of a patient and receives echoes from a volumetric region in response. Several techniques are known for ultrasonically scanning a volumetric region of the body. One is to move an ultrasound probe containing a one-dimensional array transducer over the skin in a direction normal to the image plane of the probe.

The probe will thus acquire a succession of substantially parallel image planes as the probe is moved, and the image data of the image planes comprises a 3D image dataset. This manual technique, referred to as freehand scanning, is described in U.S. Pat. 5,474,073 (Schwartz et al.) A second technique is to mechanically oscillate the transducer array back and forth inside a compartment of the probe. The probe will thus acquire the same data from a succession of substantially parallel image planes as in the freehand technique, but in this case the mechanical oscillation of the transducer array may be rapid enough to produce real time 3D images. The third approach is to use a probe with a two-dimensional array transducer, from which beams can be electronically scanned in three dimensions by phased array beam steering. A 3D probe with a two-dimensional array for this purpose is described in U.S. Pat. 5,993,390 (Savord et al.) This third approach advantageously uses a probe with no moving parts, and electronic beam steering can be done rapidly enough to scan even the heart with real time imaging. Each of these scanning techniques is capable of producing a 3D image dataset suitable for use with the present invention.

[0009] The echo signals received by the individual transducer elements of the array 12 are processed by a beamformer 14 to form coherent echo signals relating to specific points in the body. The echo signals are processed by a signal processor 16. Signal processing may include separation of harmonic echo signal components for harmonic imaging and clutter removal, for example. The processed signals are arranged into images of a desired format such as a trapezoidal sector or a cube by an image processor 18. The 3D image data is organized by its x-y-z coordinates in the volumetric region and stored in an image memory 20. The 3D image data is rendered into a three-dimensional image by a volume renderer 22. A series of volume rendered images may be dynamically displayed in kinetic parallax so that the user may rotate, re-orient and reposition the volume from different viewing perspectives as described in U.S. Pat. 6,117,080 (Schwartz). The images are processed for display by a display processor 24 which can overlay the 3D image with graphics, and the image is displayed on an image display 26.

[0010] A 3D volumetric image can also be examined by "slicing through" the volume and displaying a particular slice as a 2D image. The location of the slice in the volume is selected by user manipulation of a control on a user control interface 28. The user control will select a particular 2D plane in the 3D volume as described above, and a multi-planar reformatter 30 selects the planar data of the 3D dataset which have coordinates in the selected plane. The 2D image of the selected plane is shown on the display 26, either alone or in conjunction with the 3D image. As previously described, the user control interface can present the user with three differently colored lines or cursors, each of which can select a plane of a respective mutually orthogonal orientation. The user can thus simultaneously view three orthogonal planes through the 3D volume, as described in U.S. Pat. 6,572,547 (Miller et al.), for example.

[0011] In accordance with the principles of the present invention, the image data of a 3D volume is arranged in a sequence of images of sequential, parallel planes of the volume. The sequence of images may be stored as a sequence of frames within an ultrasound DICOM multi-frame image, which can be stored and replayed on most medical image workstations and PACS systems in the manner of a 2D image sequence stored in an ultrasound DICOM multi-frame image. A clinician can thereby view the image data of the 3D volume as a sequence of cut planes through the volume. The clinician can replay the image sequence rapidly, giving the impression of "swimming through" the volume. Or, the clinician can step through the sequence slowly or pick out a particular image in a plane which cuts through a region of interest for diagnosis. The 3D volume data can thus be reviewed as 2D images with which the clinician is more comfortable and familiar than a 3D volume image.

[0012] In the implementation of FIGURE 1, the user operates the user control interface to select the orientation of the planes of the 2D image sequence (or sequences) to be created. Standard 2D images have an azimuth (x) dimension and a depth (y) dimension and the clinician may, for example, want to have the cut planes oriented in a succession of x-y planes, each with a different z (elevation) coordinate in the volume. This selection is applied to the multi-planar reformatter 30, which selects a sequence of x-y image planes of the 3D dataset. This sequence of x-y cut plane images is coupled to an image sequencer 32, which processes the images as a succession of 2D images. The image sequence can have a proprietary (custom) format used by the particular ultrasound system, but preferably the 2D images are processed in compliance with the DICOM standard for two-dimensional medical images. With DICOM standard formatting, the image sequence can be replayed and viewed on a wide variety of medical image platforms. The 2D image sequence is stored in a Cineloop® memory 34 as a sequence or "loop" of 2D images. The image sequence can be sent to other imaging systems and platforms by way of the image data port of the ultrasound system. An image sequence of the present invention can be ported to an image review workstation in another department of a hospital over the hospital's image data network, for instance.

[0013] In a preferred implementation of the present invention the user can specify and select additional parameters of the 2D image sequence of the 3D volume. As shown in FIGURE 1, the user control interface 28 uses the same or other user controls to specify other characteristics of a 2D image sequence, including selecting the number of images of the sequence and the plane-to-plane spacing of the cut planes of the sequence. The user controls may also provide the ability for the user to select a particular sub-volume of the 3D volume for the cut planes. For example, the user may select just the central one-third of the volume for the 2D image sequence. As another example, the entire 3D volume is to be reformatted into 2D image planes in a sequence of 100 image planes. The multi-planar reformatter takes this selection and distributes the 100 cut planes at equal intervals over the volume in the selected orientation. As another example, the user selects a 2 mm plane-to-plane spacing, and the multi-planar reformatter cuts the 2D image planes at 2 mm intervals through the volume in the selected orientation.

[0014] FIGURE 2 illustrates a process for producing and exporting a 2D image sequence of a 3D volume. In step 40 the clinician scans a volumetric region of the body to acquire a 3D dataset. In step 42 the clinician observes the rendered 3D image and selects one or more plane orientations for one or more image sequences into which the volume is to be sliced by the multi-planar reformatter. The clinician may select two sequences, for example, one with the cut planes having x-y coordinates and another with the cut planes having y-z coordinates. In a constructed embodiment the selection of the plane orientation for a sequence is done by selecting and viewing a particular MPR image plane. The other images of the sequence will then be formatted in planes parallel to the selected plane. In step 44 the clinician selects the number of image planes of each sequence. The clinician may select 50 planes for the x-y plane sequence and 20 planes for the y-z plane sequence, for example. In step 46 the clinician selects the image plane spacing. The clinician may select a 1 mm spacing for the x-y planes and a 2 mm spacing for the y-z planes, for example. If the inter-plane spacing of this step is too large for the number of planes selected in step 44, the system will notify the user of the conflict so that the user can select one parameter or the other. If the inter-plane spacing selected is too small for the full volume, the system will distribute the number of plane selected with the selected inter-plane spacing about the center of the volume, where users most frequently position the region of interest. Alternatively, the user may specify a sub-region of the volume over which the planes are to be distributed. In the constructed embodiment there is no need to perform steps 44 and 46; the ultrasound system automatically produces planes of image data from one side of the 3D volume to the other, and produces image planes at the smallest plane-to-plane spacing permitted by the ultrasound system. In step 48 the multi-planar reformatter and the image sequencer produce the specified image sequence(s). In step 50 the image sequence(s) are exported to an image workstation as an ultrasound DICOM multi-frame image for review and diagnosis.

[0015] FIGURE 3 is an image display on the screen of display 26 which illustrates a grid of cut plane lines which show the user the planes which will be reformatted into sequences of 2D images. On the left side of the display screen 60 is an ultrasound image 66 which is oriented in the x-y plane. Overlaying this image 66 is a grid of vertical lines 64, which indicate a series of cuts through the volume in the y-z (elevation) direction. This grid 64 shows the user that the portion of the volume spanned by these thirty cut planes will be reformatted into a sequence of thirty 2D images in the y-z dimension. On the right side of the display is a second image 68 through the volume in the x-y dimension which is overlaid with a grid of horizontal lines 62. This grid 62 shows the user that a subregion of the volume extending from near the top of the image down to about two-thirds of the full image depth will be reformatted into a sequence of thirty C-plane images, that is, images which are each in the x-z dimension and are at successive depths (y-direction increments) of the volume. The grid 62 is backed by a graphical box 60 which at the top indicates with small tick-marks the locations of the cut planes in the y-z dimension which is set over the left-side image 66. Thus, the user can see at a glance the relative locations of the two sets of orthogonal grid lines and cut planes.

[0016] The user is also given the ability to rotate or tilt a grid 62,64 and thereby create cut plane lines which are tilted or rotated with respect to the nominal orientation of purely horizontal or vertical cut planes.

[0017] FIGURE 4 illustrates three image sequences 74, 84, 94 which are produced by an implementation of the present invention. The display screen 70 on the left side of FIGURE 4 shows an ultrasound image 72 cut through the volume in the x-y dimension, and an image sequence 74 of 2D images which are in successive x-y planes through the volume and 3D dataset. In the center of FIGURE 4 is a display screen 80 showing an image 82 in the y-z plane and below this image is an image sequence 84 of images in successive y-z cut planes through the volume and 3D dataset. On the right side of FIGURE 4 is a display screen 90 showing a C-plane (x-z dimension) 92 and below it is a sequence 94 of images cut through successive x-z planes of the volume and 3D dataset. The three image sequences show images cut through mutually orthogonal planes of the volume and 3D dataset, one which progresses in the z direction, a second which progresses in the x direction, and the third which progresses in the y direction. The user can export one, two, or all three image sequences as DICOM images to an image workstation for further analysis and diagnosis.

[0018] Since each cut plane is through the full 3D image dataset, each 2D cut plane image thus intersects and contains all of the image data acquired for the particular reformatted image. In a preferred embodiment the 2D images are in Cartesian coordinates and each image sequence is of successive cut planes in a respective orthogonal Cartesian coordinate direction. The 2D images are thus suitable for measurement and quantification to the same degree as a standard 2D image acquired by conventional means by a one-dimensional array transducer.

Claims

1. An ultrasonic diagnostic imaging system which produces three dimensional (3D) image data of a volumetric region of a body comprising:

    an ultrasound probe (10) operable to acquire a 3D image dataset of the volumetric region;
    an image data reformatter (30), responsive to the 3D image dataset and arranged to produce a plurality of 2D images (72, 82, 92);
    an image sequencer (32), responsive to the 2D images (72, 82, 92), arranged to produce a sequence of 2D images comprising cut planes which can be replayed as a 2D image sequence of a standard format;
    a data port, coupled to the image sequencer (32), by which the sequence of 2D images is arranged to be transferred to another imaging system; and
    a display (26) operable for viewing the 2D image sequence ;
    characterized in that
    the ultrasonic diagnostic imaging system further comprises a user control interface (28) operable by a user of the imaging system to select three orthogonal normal directions through the 3D image dataset, wherein the selection of each normal direction comprises selecting a 2D image plane through the 3D image dataset;
    wherein the image data reformatter (30) and the image sequencer (32) are further responsive to the selection and arranged to produce three sequences of 2D images (74, 84, 94) from the 3D dataset, wherein the 2D images of each sequence are parallel to the plane of the selected 2D image plane corresponding to this sequence, and
    wherein the user control interface (28) is further operable by the user to select a plane-to-plane spacing of the cut planes corresponding to the 2D images.

2. The ultrasonic diagnostic imaging system of Claim 1, wherein image sequencer (32) is further operable to produce a sequence of 2D images (74, 84, 94) which is in accord with the DICOM format.

3. The ultrasonic diagnostic imaging system of Claim 2, wherein the other imaging platform is operable to replay the sequence of 2D images (74, 84, 94) as a DICOM image sequence.

4. The ultrasonic diagnostic imaging system of Claim 1, further comprising a Cineloop memory (34) which is operable to store the sequences of 2D images (74, 84, 94) produced by the image sequencer (32) as an image Cineloop, wherein the sequences of 2D images (74, 84, 94) can be replayed on the display.

5. The ultrasonic diagnostic imaging system of Claim 4, wherein the sequence of 2D images (74, 84, 94) can be replayed from the Cineloop memory (34) as a real time image sequence, or can be played and stopped to view a particular one of the 2D images on the display (26).

6. The ultrasonic diagnostic imaging system of Claim 1, further comprising a volume renderer (22), responsive to the 3D image dataset, arranged to produce a rendered 3D ultrasound image, wherein the display (26) is further operable to display the rendered 3D ultrasound image.

7. The ultrasonic diagnostic imaging system of Claim 1, further comprising a display processor (24), coupled to the display (26), arranged to produce a graphic overlaying an ultrasound image acquired by the probe (10) that indicates the spatial locations of a sequence of 2D image planes (74, 84, 94).

8. The ultrasonic diagnostic imaging system of Claim 7, wherein the graphic further comprises a grid of cut plane lines (62, 64), and further comprising a user control (28) by which a user can adjust at least one of the number of cut planes of the grid, the spacing of the cut planes of the grid, and the position of the cut planes relative to the spatial location of the volumetric region.

9. The ultrasonic diagnostic imaging system of Claim 8, wherein the user control interface (28) enables a user to rotate or tilt the cut planes through the volumetric region.

Patentansprüche

1. Ultraschallsystem zur diagnostischen Bildgebung, das dreidimensionale (3D) Bilddaten einer volumetrischen Region eines Körpers erzeugt, umfassend:

    eine Ultraschallsonde (10), die funktionsfähig ist, um einen 3D-Bilddatensatz der volumetrischen Region zu erfassen;
    eine Bilddaten-Umformatierungseinheit (30), die auf den 3D-Bilddatensatz reagiert und dafür vorgesehen ist, eine Vielzahl von 2D-Bildern (72, 82, 92) zu erzeugen;
    eine Bildsequenzierungseinheit (32), die auf die 2D-Bilder (72, 82, 92) reagiert und dafür vorgesehen ist, eine Sequenz von 2D-Bildern mit Schnittebenen zu erzeugen, die als eine 2D-Bildsequenz von einem Standardformat wiedergegeben werden können;
    einen Datenport, der mit der Bildsequenzie-

rungseinheit (32) gekoppelt ist und über den die Sequenz von 2D-Bidlern an ein anderes Bildgebungssystem übertragen werden kann; und
eine Anzeige (26), die funktionsfähig ist, um die 2D-Bildsequenz anzuzeigen;
dadurch gekennzeichnet, dass
das Ultraschallsystem zur diagnostischen Bildgebung weiterhin eine Benutzersteuerungsschnittstelle (28) umfasst, die durch einen Benutzer des Bildgebungssystems betätigt werden kann, um drei orthogonale normale Richtungen durch den 3D-Bilddatensatz auszuwählen, wobei die Auswahl von jeder normalen Richtung das Auswählen einer 2D-Bildebene durch den 3D-Bilddatensatz umfasst;
wobei die Bilddaten-Umformatierungseinheit (30) und die Bildsequenzierungseinheit (32) weiterhin auf die Auswahl reagieren und dafür vorgesehen ist, drei Sequenzen von 2D-Bildern (74, 84, 94) aus dem 3D-Datensatz zu erzeugen, wobei die 2D-Bilder jeder Sequenz parallel zu der Ebene der ausgewählten 2D-Bildebene liegen, die dieser Sequenz entspricht, und
wobei die Benutzersteuerungsschnittstelle (28) weiterhin durch den Benutzer betätigt werden kann, um einen Ebene-zu-Ebene-Abstand der Schnittebenen entsprechend den 2D-Bildern auszuwählen.

2. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 1, wobei die Bildsequenzierungseinheit (32) weiterhin funktionsfähig ist, um eine Sequenz von 2D-Bildern (74, 84, 94) zu erzeugen, die mit dem DICOM-Format übereinstimmt.

3. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 2, wobei die andere Bildgebungsplattform funktionsfähig ist, um die Sequenz von 2D-Bildern (74, 84, 94) als eine DICOM-Bildsequenz wiederzugeben.

4. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 1, weiterhin umfassend einen Cineloop-Speicher (34), der funktionsfähig ist, um die durch die Bildsequenzierungseinheit (32) erzeugten Sequenzen von 2D-Bildern (74, 84, 94) als eine Bild-Cineloop zu speichern, wobei die Sequenzen von 2D-Bildern (74, 84, 94) auf der Anzeige wiedergegeben werden können.

5. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 4, wobei die Sequenz von 2D-Bildern (74, 84, 94) aus dem Cineloop-Speicher (34) als eine Echtzeitbildsequenz wiedergegeben werden kann oder abgespielt und gestoppt werden kann, um ein bestimmtes der 2D-Bilder auf der Anzeige (26) anzusehen.

6. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 1, weiterhin umfassend eine Volumenrendering-Einheit (22), die auf den 3D-Bilddatensatz reagiert und dafür vorgesehen ist, ein gerendertes 3D-Ultraschallbild zu erzeugen, wobei die Anzeige (26) weiterhin funktionsfähig ist, um das gerenderte 3D-Ultraschallbild anzuzeigen.

7. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 1, weiterhin umfassend einen Anzeigeprozessor (24), der mit der Anzeige (26) gekoppelt ist und dafür vorgesehen ist, eine Grafik zu erzeugen, die ein durch die Sonde (10) erfasstes Ultraschallbild überlagert und die räumlichen Orte einer Sequenz von 2D-Bildebenen (74, 84, 94) angibt.

8. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 7, wobei die Grafik weiterhin ein Gitter aus Schnittebenenlinien (62, 64) umfasst und weiterhin eine Benutzersteuerung (28) umfasst, durch die ein Benutzer mindestens entweder die Anzahl von Schnittebenen des Gitters, den Abstand der Schnittebenen des Gitters oder die Position der Schnittebenen in Bezug auf den räumlichen Ort der volumetrischen Region anpassen kann.

9. Ultraschallsystem zur diagnostischen Bildgebung nach Anspruch 8, wobei die Benutzersteuerungsschnittstelle (28) einem Benutzer ermöglicht, die Schnittebenen durch die volumetrische Region zu drehen oder zu kippen.

Revendications

1. Système d’imagerie à diagnostic à ultrasons qui produit des données d’image tridimensionnelle (3D) d’une région volumétrique d’un corps comprenant :

une sonde à ultrasons (10) pouvant être actionnée à acquérir un ensemble de données d’image en 3D de la région volumétrique ;
un reformateur de données d’image (30), répondant à l’ensemble de données d’image en 3D et agencé pour produire une pluralité d’images en 2D (72, 82, 92) ;
un séquenceur d’image (32), répondant aux images en 2D (72, 82, 92), agencé pour produire une séquence d’images en 2D comprenant des plans de coupe qui peuvent être relus sous forme d’une séquence d’images en 2D d’un format standard ;
un port de données, couplé au séquenceur d’image (32), par lequel la séquence d’images en 2D est agencée pour être transférée à un autre système d’imagerie ; et
un dispositif d’affichage (26) destiné à visualiser la séquence d’images en 2D ;

caractérisé en ce que

le système d'imagerie à diagnostic à ultrasons comprend en outre une interface de commande utilisateur (28) pouvant être actionné par un utilisateur du système d'imagerie pour sélectionner trois directions normales orthogonales à travers l'ensemble de données d'image en 3D, dans lequel la sélection de chaque direction normale comprend la sélection d'un plan d'image en 2D à travers l'ensemble de données d'image en 3D ;

dans lequel le reformateur de données d'image (30) et le séquenceur d'image (32) répondent en outre à la sélection et sont agencés pour produire trois séquences d'images en 2D (74, 84, 94) à partir de l'ensemble de données en 3D, dans lequel les images en 2D de chaque séquence sont parallèles au plan du plan d'image en 2D sélectionné correspondant à cette séquence, et

dans lequel l'interface de commande utilisateur (28) peut en outre être actionnée par l'utilisateur afin de sélectionner un espacement plan à plan des plans de coupe correspondant aux images en 2D.

2. Système d'imagerie à diagnostic à ultrasons selon la revendication 1, dans lequel le séquenceur d'image (32) peut en outre être actionné pour produire une séquence d'images en 2D (74, 84, 94) qui est conforme au format DICOM.

3. Système d'imagerie à diagnostic à ultrasons selon la revendication 2, dans lequel l'autre plateforme d'imagerie peut être actionnée pour relire la séquence d'images en 2D (74, 84, 94) en tant que séquence d'images DICOM.

4. Système d'imagerie à diagnostic à ultrasons selon la revendication 1, comprenant en outre une mémoire Cineloop (34) qui peut être actionnée pour stocker les séquences d'images en 2D (74, 84, 94) produites par le séquenceur d'image (32) en tant qu'image Cineloop, dans lequel les séquences d'images en 2D (74, 84, 94) peuvent être relues sur le dispositif d'affichage.

5. Système d'imagerie à diagnostic à ultrasons selon la revendication 4, dans lequel la séquence d'images en 2D (74, 84, 94) peut être relue depuis la mémoire Cineloop (34) en tant que séquence d'images en temps réel, ou peut être lue et arrêtée pour visualiser une image particulière des images en 2D sur le dispositif d'affichage (26).

6. Système d'imagerie à diagnostic à ultrasons selon la revendication 1, comprenant en outre un dispositif de rendu de volume (22), répondant à l'ensemble de données d'image en 3D, agencé pour produire une image à ultrasons en 3D rendue, dans lequel le dispositif d'affichage (26) peut en outre être actionné pour afficher l'image à ultrasons en 3D rendue.

7. Système d'imagerie à diagnostic à ultrasons selon la revendication 1, comprenant en outre un processeur d'affichage (24), couplé au dispositif d'affichage (26), agencé pour produire un graphique recouvrant une image à ultrasons acquise par la sonde (10) qui indique les emplacements spatiaux d'une séquence de plans d'image en 2D (74, 84, 94).

8. Système d'imagerie à diagnostic à ultrasons selon la revendication 7, dans lequel le graphique comprend en outre une grille de lignes de plans de coupe (62, 64), et comprenant en outre une commande utilisateur (28) par laquelle un utilisateur peut ajuster au moins un critère parmi le nombre de plans de coupe de la grille, l'espacement des plans de coupe de la grille et la position des plans de coupe par rapport à l'emplacement spatial de la région volumétrique.

9. Système d'imagerie à diagnostic à ultrasons selon la revendication 8, dans lequel l'interface de commande utilisateur (28) permet à un utilisateur de tourner ou d'incliner les plans de coupe à travers la région volumétrique.

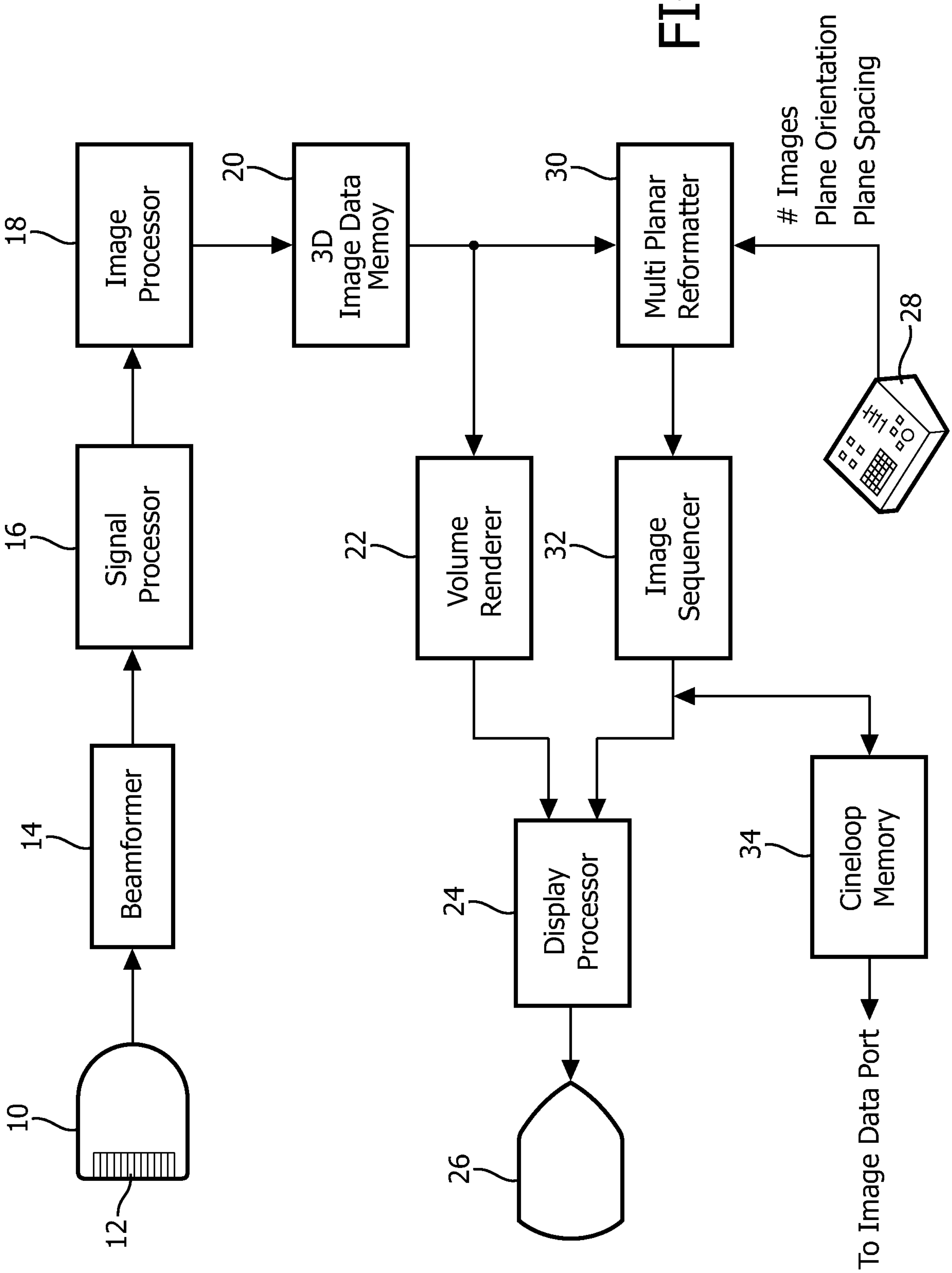
10
12
14
Beamformer
16
Signal Processor
18
Image Processor
20
3D Image Data Memoy
22
Volume Renderer
24
Display Processor
26
28
Images
Plane Orientation
Plane Spacing
30
Multi Planar Reformatter
32
Image Sequencer
34
Cineloop Memory
To Image Data Port

FIG. 1

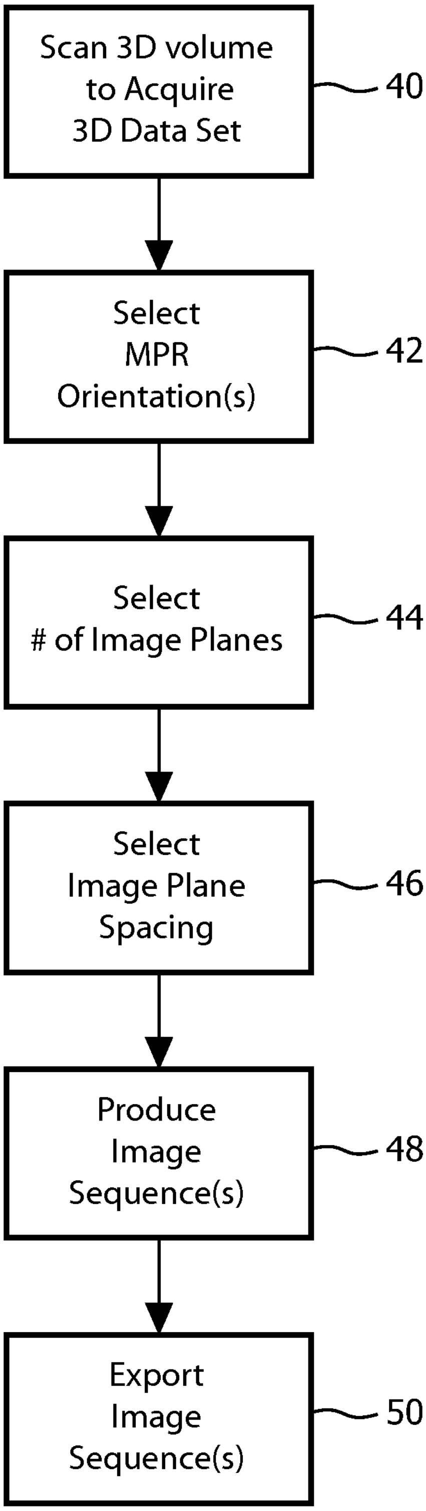
Scan 3D volume to Acquire 3D Data Set
40
Select MPR Orientation(s)
42
Select # of Image Planes
44
Select Image Plane Spacing
46
Produce Image Sequence(s)
48
Export Image Sequence(s)
50

FIG. 2

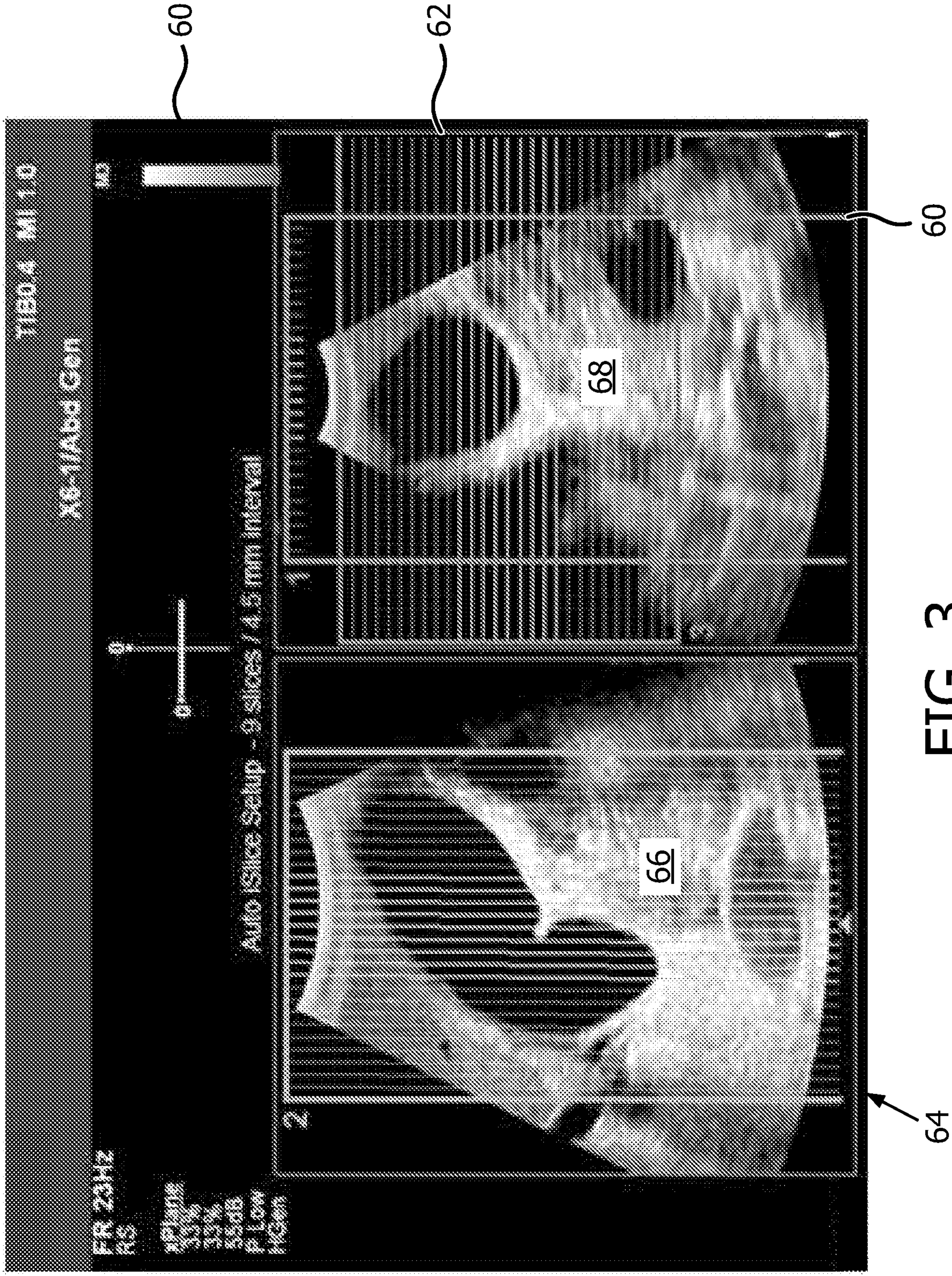
X6-1/Abd Gen
TIB0.4 MI 1.0
Auto iSlice Setup - 9 slices / 4.5 mm interval
FR 23Hz
RS
60
62
60
64
66
68

FIG. 3

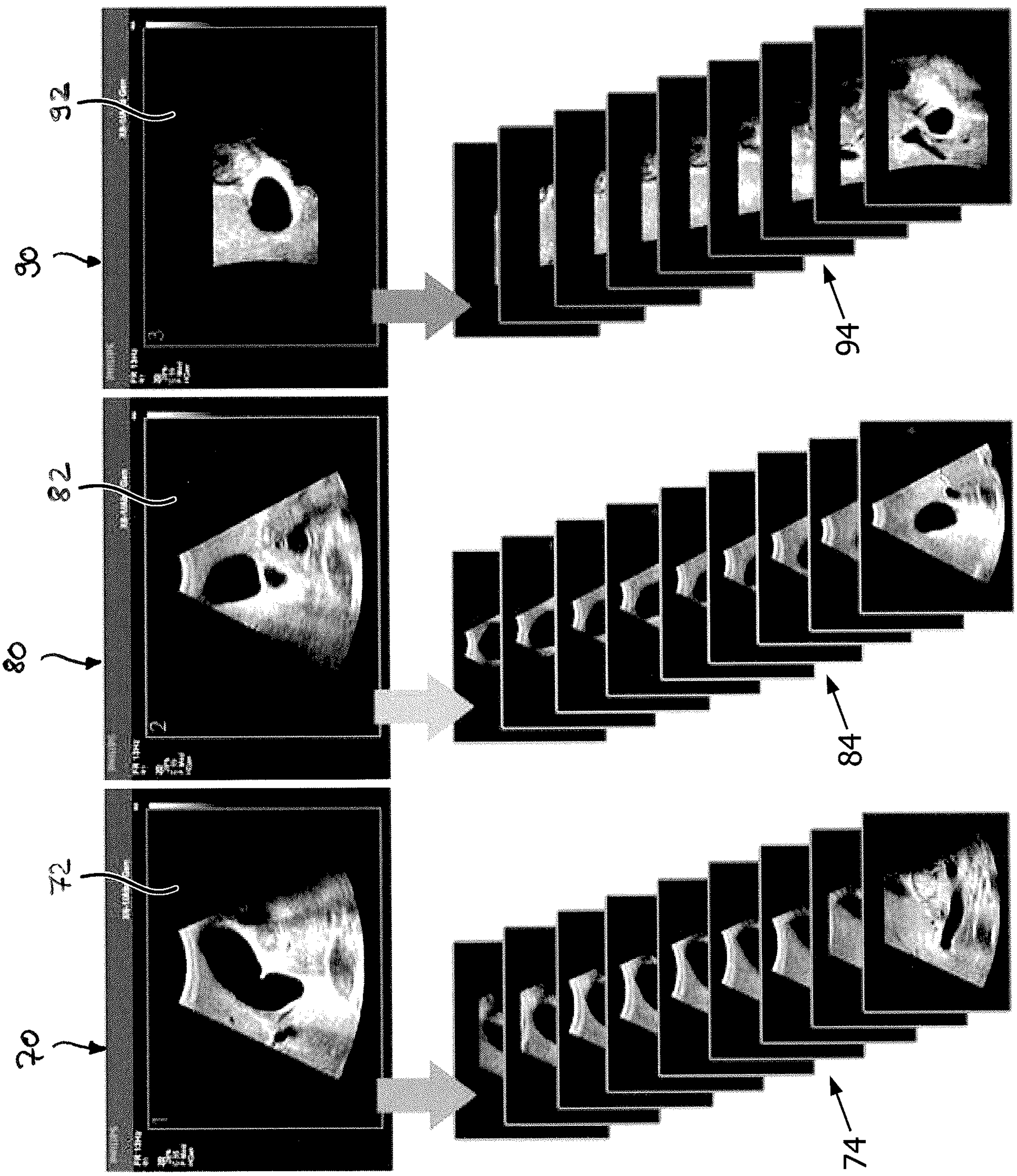

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	体积超声图像数据被重新格式化为图像平面序列		
公开(公告)号	EP2549930B1	公开(公告)日	2017-11-15
申请号	EP2011718159	申请日	2011-03-17
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
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发明人	BROWN, JIMMY, RAY BRADLEY, KEVIN		
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优先权	61/316471 2010-03-23 US		
其他公开文献	EP2549930A1		
外部链接	Espacenet		

摘要(译)

超声探头获取身体的体积区域的3D图像数据集。将3D图像数据重新格式化为一系列连续的平行图像平面，这些平面图像平面在通过该体积的三个正交方向之一中延伸。优选地，图像序列（74,84,94）根据DICOM标准格式化，使得临床医生可以将3D图像数据作为图像工作站上的DICOM图像序列进行查看。